CHAPTER 8

GROUND-WATER MONITORING

8-1. Introduction

a. Subpart F of 40 CFR 264 establishes standards for groundwater protection and monitoring that apply to owners or operators who treat, store or dispose of hazardous waste in surface impoundments, waste piles, land treatment units, or landfills.

b. Under Interim Status regulations in 40 CFR 265:F, existing surface impoundments, landfills or land treatment facilities are also required to implement ground-water monitoring programs to determine the facilities' impact on ground water.

c. If an existing facility is upgraded, the facility owner or operator must continue to comply with the interim status regulations specified in 40 CFR 265:F until final administrative action on the facility's permit application. Initial background water quality data collected during this period is used for the detection and/or compliance monitoring programs regulated by 40 CFR 264:F once a permit is granted to the facility. The designer should be aware, however, that the monitoring system installed at existing facilities in compliance with the interim status regulations may not meet the more stringent standards for permitted facilities and may require modifications or additions.

d. Many variables exist within a given hydrogeologic environment that affect ground-water occurrence. To yield usable information, as well as to ensure their effectiveness, monitoring programs must therefore be designed based on a thorough knowledge of site hydrogeology (EPA SW-963, SW-611).

8-2. Monitoring requirements

a. Background ground-water quality. Section 264.97 requires that ground-water quality data be collected at all hazardous waste units to establish a background value for any hazardous constituents or monitoring parameters specified in the facility permit. Sampling frequency and techniques are detailed in the regulations.

b. Detection monitoring. A detection monitoring program (section 264.98) is required at all hazardous waste units to provide an early indication of leakage into the uppermost aquifer.

(1) Detection monitoring, conducted at least semiannually, determines ground-water quality at the point of compliance. The parameters or constituents requiring monitoring are specified in the facility permit.

(2) The information collected is analyzed to determine whether there has been a statistically significant increase over background values for any parameter or constituent specified in the permit. If so, the EPA Regional Administrator (RA) establishes a ground-water protection standard for the facility.

c. Ground-water protection standard. The groundwater protection standard indicates when corrective action is necessary to control contamination from a regulated hazardous waste unit. The standard has four main parts: (1) the hazardous constituents to be monitored (section 264.93), (2) the concentration limits for each hazardous constituent that trigger corrective action (section 264.94), (3) the point of compliance (section 264.95), and (4) the compliance period (section 264.96).

d. Compliance monitoring. Compliance monitoring (section 264.99) is implemented when detection monitoring reveals a confirmed, statistically significant increase in any parameter or constituent specified.

(1) Compliance monitoring requires quarterly sampling at the compliance point for hazardous constituents specified in the ground-water protection standard. Analysis for all appendix VIm of 40 CFR 261 hazardous constituents must also be done annually.

(2) Data collected from these tests are analyzed to determine if a statistically significant increase in hazardous constituent concentration has occurred. If so, a corrective action program is implemented at the RA's direction.

e. Corrective action program. A corrective action program (section 264.100) is undertaken to ensure that hazardous waste units are brought into compliance with the ground-water protection standard. This goal must be achieved by either removing the hazardous constituents or treating them in place. Corrective action may be terminated only after ground-water monitoring data demonstrate that the standard has not been exceeded for three consecutive years.

8-3. Monitoring program

a. Determining the hydrogeologic environment of a waste disposal unit is an essential first step in designing and planning a monitoring program. The hydrogeologic investigation should include identification of the uppermost aquifer, determination of the hydraulic conductivity of underlying formations, and determination of seasonal and other fluctuations in ground-water surface elevation, which will yield information on hydraulic gradients and flow direction. Subsurface cross-sections, prepared from boring logs, geophysical surveys and existing site information, may be used in conjunction with a base map to characterize the hydrogeologic environment of the site. Methods of determining hydrogeologic conditions are detailed in chapter 3 of this manual.

b. A minimum of four ground-water monitoring wells will be installed, one hydraulically upgradient of the waste disposal unit, to provide background groundwater quality data, and three downgradient of the facility to detect contaminant discharge. Small indoor waste piles are the only waste facilities at which fewer wells will be considered.

c. Upgradient wells should be installed in the uppermost aquifer at a location not likely to be affected by the waste facility. Downgradient wells should also be installed in the uppermost aquifer, but along pathways likely to transport contaminants, should any be released from the facility. Care must be taken in locating and constructing monitoring wells to ensure that they not serve as conduits for contaminants to enter the ground water, or allow contaminated ground water to migrate to an uncontaminated aquifer.

d. Well depth should be determined on a sitespecific basis. Factors which influence well depth, as well as the depth of the sampling (or intake) interval of the well casing, include ground-water levels and the behavior of specific contaminants in the aquifer. These determinations are dependent on a detailed log of borings and on the subsurface geologic conditions. e. The principal components of the monitoring well are the well casing and the perforated or screened sampling interval. A typical ground-water monitoring well is shown on figure 8-1. Details on well design and sampling methods appear in SW-611 and in the RCRA guidance manual on ground-water monitoring. It must be stressed that well design must always be based on a clear and detailed understanding of site hydrogeologic conditions.

(1) One of the considerations in design of the well is selection of the proper well diameter, which depends on a number of factors, including state and federal requirements, drilling method and subsurface conditions, as well as the diameter of the sampler. Monitoring wells generally have casing diameters of either 2 or 4 inches. The larger casing size permits greater flexibility in sampling methods, since an inner diameter of 4 inches is generally required to accommodate submersible pumps and other equipment used for evacuation and sampling. Two-inch casings may be necessary or favorable in some instances, however, since they can be installed by the dry hollow-stem continuous flight auger drilling method. Some drill rigs can install 4-inch casings but such rigs are not always readily available.

(2) Proper location of the intake, or sampling, interval of the monitoring well is extremely important to ensure that it is in the path of likely contaminants and therefore likely to yield representative samples. Where aquifer zones are relatively thin (i.e., no more than 20 feet thick), the well should be perforated throughout the zone. In thicker aquifers, multiple wells (see figure 8-2) should be used to define water quality stratification within the aquifer. Care should be taken to ensure that the perforated interval does not provide hydraulic connection between isolated aquifers.

(3) Also important is the sizing of the perforations or screen. A properly sized screen, generally one designed to exclude up to 60 percent of formation materials, will prevent passage of fines from the formation, while allowing passage of sufficient water for sampling. In most cases a commercially fabricated screen is recommended, although a factory-slotted casing may be adequate for some applications. Field perforation of well casings is not recommended.

(4) Materials selected for the well casing should be compatible with the expected contaminants to minimize the potential for interaction between the casing material and the sample. Steel casings may contribute iron and other ions to the sample. Furthermore, the metallic oxides which form on a steel casing influence concentrations of cautions and some organic molecules. PVC pipe, unlike steel well casing, is resistant to most chemicals, nonconductive, and chemically inert; however, PVC is not recommended for sampling certain reactive organic constituents such as ketones or aromatic compounds, which can better be accomplished using stainless steel or teflon. However, the final selection of well materials should be determined by a person knowledgeable about the probable chemical reactions (e.g., a chemist or chemical engineer). Needed joints in PVC casings should be fashioned using threaded couplings instead of glue to avoid contamination.

(5) Locking caps and concrete pads should be installed on all monitoring wells. Pads should be designed to divert drainage from the casing, thereby preventing precipitation or extraneous substances from entering the well.

f. Well drilling methods, filter packing, sealing and development are the components of concern in well construction, both to maintain the integrity of the borehole and to prevent contamination of samples.

(1) The drilling method selected should avoid spreading any ground-water contamination and/or interfering with the sample to be collected. Both dry and wet drilling methods are commonly used to construct monitoring wells. Conventional auger drilling is advantageous, since the potential for introducing extraneous fluids is less than with rotary drilling methods. Auger drilling is best suited to fine-grained, nonconsolidated materials; rotary (air or water) drilling is required for wells in cemented or consolidated materials such as bedrock. The maximum casing diameter in wells drilled by the standard continuous flight auger

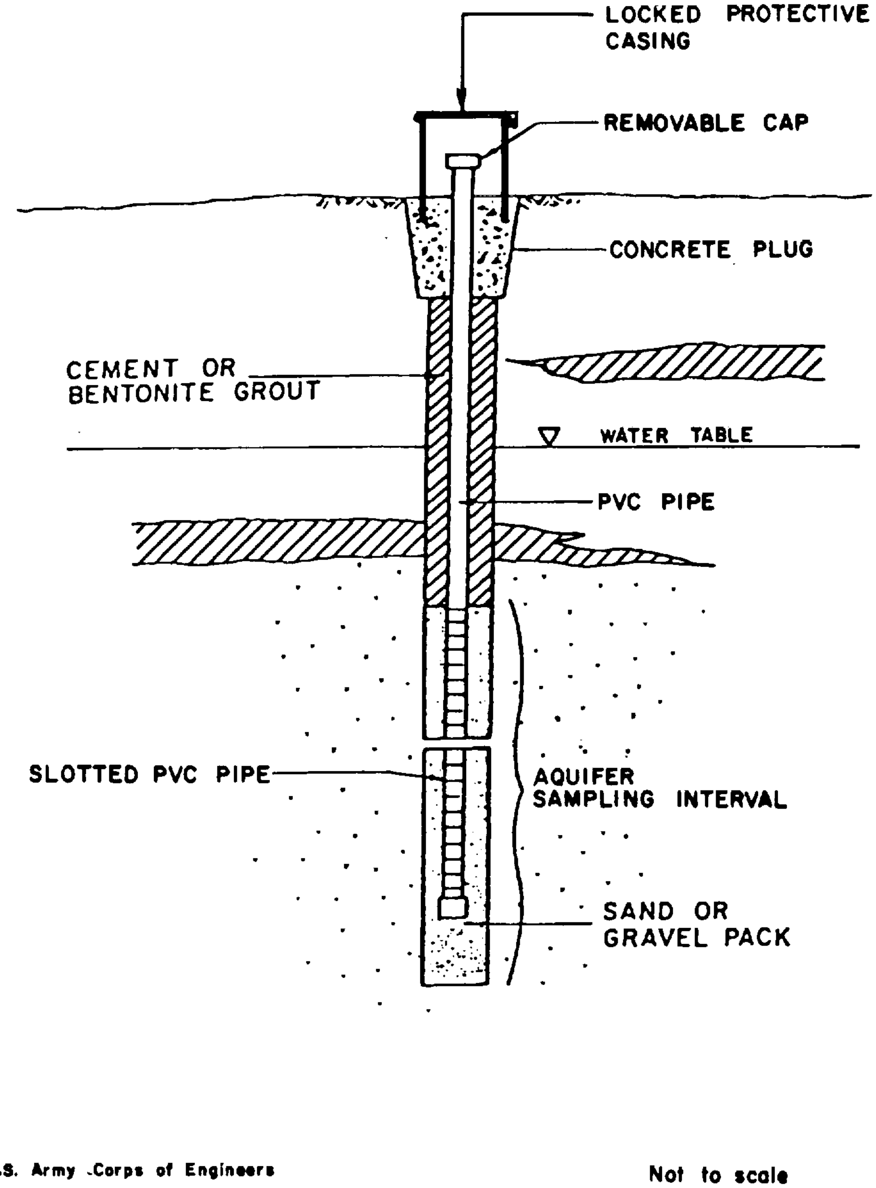

Figure 8-1. Monitoring well details.

method is 4 inches (2 inches if inserted into hollowstem augers). However, larger non-continuous auger drilling equipment can be used in primarily finegrained deposits to install shallow wells with casing diameters up to 12 inches.

(2) If well drilling methods are employed, drilling fluids should be chosen to minimize contamination, and care should be taken to prevent entry of drilling fluids into aquifer flow zones. Generally, all additives or drilling fluids are disallowed at DA facilities except clean water and/or bentonite clay. When subsurface or contaminant conditions warrant, a variance should be requested and justification submitted to the Major Command for consideration.

(3) Filter packing is used to develop a zone of in-creased hydraulic conductivity around the sampling interval and to prevent clogging. The filter pack consists of gravel or sand placed in the borehole around the sampling interval of the well (see figure 8-2).
Selection of the grain-size of a filter pack requires sampling and sieve analysis of the aquifer materials.
Proper installation of the filter pack is necessary to prevent separation of the fine and coarse particles and consequent bridging of the material, which could result in formation of void spaces. Use of a tremie pipe is recommended for installation of the filter pack; however in shallow wells, slow pouring or shovelling may be acceptable. For wells drilled in soil, the minimum boring diameter in the filter pack portion of the well should be at least 4 inches larger than the inner diame

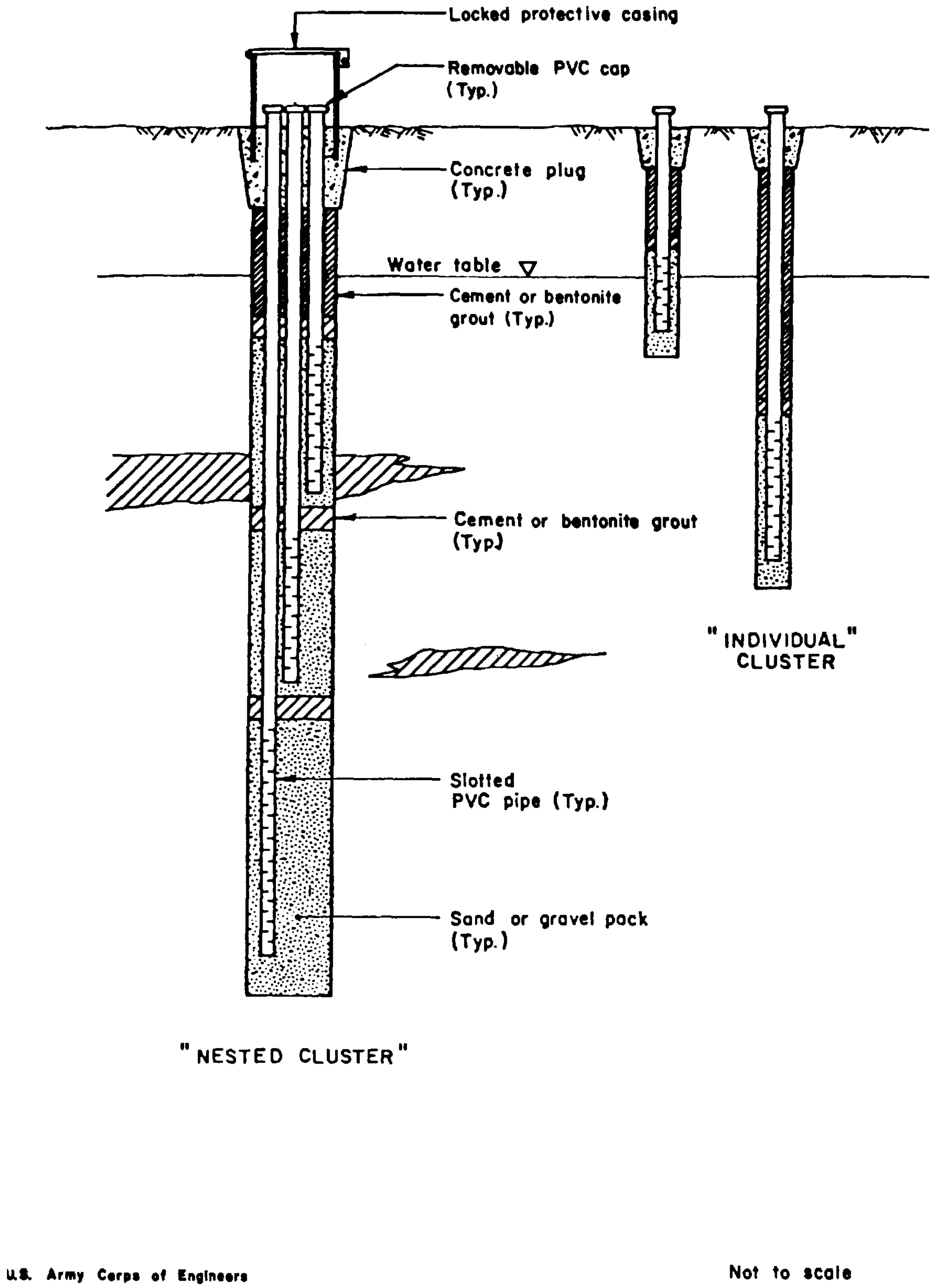

Figure 8-2. Monitoring well installations.

ter of the screened interval; in wells drilled in rock, well diameters may be as little as 2 inches larger than the screened interval.

(4) Regulations in 40 CFR 264:F require that the annular space between the well casing and the borehole be sealed to prevent contamination of the ground water and/or sample. Both cement grout and bentonite are effective agents that are commonly used for sealing monitoring wells. If portland cement is used, special care should be taken to minimize shrinkage, as well as to prevent migration of the grout into adjacent formations. Alternatively, a grout mixture of portland cement, sand, bentonite and water can be used. If bentonite is used, a 3to 5-foot seal of bentonite pellets must be placed between the well casing and the borehole. A base of sand may also be necessary around and above the screen. Installation of sealing agents is best accomplished with a tremie pipe; pouring and tamping may, however, be adequate for shallow wells of small diameter.

(5) Well development is necessary to ensure the free flow of water into the sampling interval, to purge drilling fluids and other contaminants, and to eliminate clay, silt and other fines which could contribute to water turbidity and interfere with chemical analysis. In developing the well, ground water within the casing is repeatedly forced in and out of the sampling interval by flow reversal or surge. The well is then pumped or bailed until a volume of clear water equal to that required for operation of the sampling program is obtained. If the well cannot be adequately developed, it should be replaced with a new well.

g. Federal regulations for both existing facilities and new facilities require that a ground-water sampling and analysis plan be prepared which details procedures and techniques to be followed in collecting, preserving, shipping and analyzing samples.

(1) Water level measurements are required each time a sample is collected. Such measurements are necessary to detect seasonal changes or other fluctuations in the water table which could affect flow direction and the well's ability to yield a representative sample.

(2) Before a sample is withdrawn, standing water should be purged from the well. This is an important procedure, since such water can have substantially different chemical characteristics from the ground water to be sampled, due to dissolution of gases; leaching or adsorption of casing, screen or grout materials; and/or biological activity within the well. It is generally recommended that wells be completely evacuated before sampling. High-yield wells should, if possible, be pumped dry twice and allowed to recover before sampling; one complete evacuation is sufficient for lowyield wells. If complete evacuation is not possible, a volume of water equal to 4 to 10 times the amount of standing water should be withdrawn. The exact volume to be withdrawn will depend on site-specific conditions.

(3) A variety of sampling devices are available, including bailers, portable pumps, air-lift sampler and suction pumps. Care should be taken to choose equipment that will not contaminate the sample, particularly when trace elements are to be analyzed. All equipment should be thoroughly cleaned before introduction into a monitoring well. Once a sampling device has been chosen, the same equipment and sampling procedure should be used in subsequent sampling, if values are to be compared.

(4) Accepted procedures for preserving and protecting ground-water samples during shipping and while awaiting laboratory analysis should be followed. All samples should be firmly sealed, clearly labelled and packed in compatible containers that will prevent breakage, spills and contamination. The sampling schedule and methods of analysis should be according to the regulations in 40 CFR 264:F and the guidelines presented in the RCRA ground-water monitoring guidance manual.